UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)	
Predmet:	Porazdeljeni sistemi
Course title:	Distributed systems

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	3	prvi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	3	first

Vrsta predmeta / Course type	izbirni / elective	

Univerzitetna koda predmeta / University course code:	63261

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work		ECTS
45	10	20			105		6

Nosilec predmeta / Lecturer:	prof. dr. Uroš Lotrič

Jeziki / **Languages:**	**Predavanja /** **Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija.	Enrolment in the programme.

Vsebina:	**Content (Syllabus outline):**

Uvod: cilji paralelizacije, komunikacija in koordinacija, programerske napake

Dekompozicija problema: podatkovni in funkcijski paralelizem, cevovod, raztegljivost

Komunikacija in koordinacija: večprocesorski sistemi (deljeni pomnilnik, sovisnost predpomnilnika, medsebojno izključevanje, prepreke, pogojne spremenljivke), večračunalniški sistemi (izmenjevanje sporočil, točka-točka in skupinsko, latenca in pasovna širina)

Paralelni algoritmi, analiza in programiranje: koncepti in primeri uporabe (nerodno paralelni algoritmi, deli in vladaj, razprši in združi, gospodar-suženj), analiza (pohitritev in Amdahlov zakon, raztegljivost)

Paralelne arhitekture: Flynnovo označevanje, večprocesorski sistemi (SIMD, UMA, NUMA), večračunalniški sistemi (gruča, grid, oblak), grafične procesne enote in moderni koprocesorji in heterogeni sistemi, povezovanje (vodila, mreže)

Zmogljivost paralelnih sistemov: uravnavanje obremenitve, razporejanje opravil, stroški komunikacije, vpliv predpomnilnika, prostorska in časovna lokalnost, energijska učinkovitost

Teoretični modeli paralelnega računanja: modeli paralelnega računanja (PRAM, BSP), modeli izmenjevanja sporočil (CSP), modeliranje odvisnosti v algoritmu, modeli zagotavljanja skladnosti v sistemih z deljenim pomnilnikom

Porazdeljeni sistemi: napake na mreži in vozliščih, razpoložljivost, kompromisi pri načrtovanju sistemov in servisnih storitev, primeri porazdeljenih algoritmov (volitve, | Fundamentals: goals, communication, coordination, programming errors

Parallel decomposition: data and functional paralelism, pipeline, scalability

Communication and coordination: shared-memory systems (shared memory, cache coherence, mutual exclusion, barriers, conditional variables, semaphores), distributed-memory systems (message passing, point-to-point versus multicast, latency and throughput)

Parallel algorithms, analysis and programming: concepts and examples (embarisingly parallel algorithms, divide and conquer, map reduce, master slave), analyis (speedup and Amdahl's law, scalability)

Parallel architectures: Flynn's taxonomy, shared-memory systems (SIMD, UMA, NUMA), distributed-memory systems (cluster, grid, cloud), graphic processing units, modern coprocessors and heterogeneous systems, topologies (buses and interconnects)

Parallel performance: load balancing, scheduling and contention, communication overhead, cache effects, spatial and temporal datal locality, energy efficiency

Theoretical models of parallel computing: formal models of parallel computation (PRAM, BSP), formal models of message passing (CSP), formal models of computational dependencies, models of shared memory consistency

Distributed systems: network- and node-based faults, availability, distributed system and service design tradeoffs, examples of distributed algorithms (election, discovery) |

odkrivanje)

Temeljni literatura in viri / Readings:

P.S. Pacheco. An Introduction to Parallel Programming, Morgan Kaufman, 2011.

M. J. Quinn. Parallel Programing in C with MPI and OpenMP. Mc Graw Hill, 2003.

B.R. Gaster et. al. Heterogeneous computing with OpenCL. Morgan Kaufmann, 2013.

G. Couloris et al. Distributed Systems: Concepts and Design. Pearson, 2012.

Cilji in kompetence:

Pridobiti osnovno teoretično in praktično znanje s področij vzporednih in porazdeljenih sistemov, paralelnega programiranja in procesiranja. Razumeti računalniška omrežja, medprocesorsko komunikacijo in značilnosti snovanja paralelnih algoritmov. Naučiti se programiranja sistemov s knjižnicami pThreads, OpenMP, OpenCL in MPI. Razumeti Grid in koncept računalništva v oblaku. Seznaniti se s trendi razvoja.

Objectives and competences:

To get the basic theoretical and practival knowledge from the areas of parallel and distributed systems, parallel programming and processing. To understand computer networks, inter-process communication and features of parallel algorithm design. To learn programming with pThreads, OpenMP, CUDA, and MPI. To understand Grid and concept of cloud computing. To realize future trends.

Predvideni študijski rezultati:

Znanje in razumevanje:

Poznavanje pristopov, metod, arhitektur ter instrumentov upravljanja informatike.

Razumevanje strateškega planiranja in izbranih metod upravljanja informatike.

Intended learning outcomes:

Knowledge and understanding:

The course focuses on the basic concepts of parallel and distributed systems, their architecture, communication, and coordination among elements. Important part of the course is in theorethical analysis and programming of important parallel agorithms, including parallel

Uporaba:

Uporaba mehanizmov upravljanja informatike pri delu informatika.

Refleksija:

Razumevanje skladnosti med teorijo upravljanja informatike in praktičnim ravnanjem na podlagi konkretnih primerov uporabe v poslovnih sistemih ter najboljših praks.

Prenosljive spretnosti - niso vezane le na en

predmet:

Metode upravljanja informatike povezujejo med seboj različne vidike informatike, predstavljajo celostno obvladovanje informatike in so tako uporabne v okviru vseh področij informatike kot dela poslovnega sistema.

decomposition, theoretical analysis based on formal theoretical models, and perofrmance evaluation.

Application:

Student with skills gained in this course will be capable of designing, programming, and evaluating parallel and or distributed systems.

Reflection:

Awareness and understanding of connection between the theory and its application on parallel and distributed systems.

Transferable skills:

Capability of reading and understanding domestic and foreign technical literature, gathering and interpreting data, identifying and solving problems, critical analysis and evaluation of the usefulness of parallelization of distributed system and/or algorithms.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarji, laboratorijske vaje, projektno delo na laboratorijskih vajah, individualne domače naloge.	Lectures, laboratories, homework

	Delež (v %) /	
Načini ocenjevanja:	Weight (in %)	**Assessment:**

Način (ustno izpraševanje, domače naloge, projektno delo):		Type (examination, oral, coursework, project):
Domače naloge	33 %	one project
Projekt	33 %	two examinations during semester or oral examination
Ustni izpit	34 %	active participation on lectures
Ocene: 6-10 pozitivno, 1-5 negativno		Grading: 6-10 pass, 1-5 fail. (According to the UL Statues)
(v skladu s Statutom UL)		

Reference nosilca / Lecturer's references:

LOTRIČ, Uroš, DOBNIKAR, Andrej. Parallel implementations of recurrent neural network learning. V: KOLEHMAINEN, Mikko (ur.), TOIVANEN, Pekka (ur.), BELICZYŃSKI, BartĺOmiej (ur.). Adaptive and natural computing algorithms : 9th international conference, ICANNGA 2009, Kuopio, Finland, April 23-25, 2009 : revised selected papers, (Lecture notes in computer science, ISSN 0302-9743, 5495). Berlin, Heidelberg, New York: Springer, cop. 2009, str. 99-108, ilustr. [COBISS.SI-ID 7346004]

SILVA, Catarina, LOTRIČ, Uroš, RIBEIRO, Bernardete, DOBNIKAR, Andrej. Distributed text classification with an ensemble kernel-based learning approach. IEEE transactions on systems, man and cybernetics. Pt. C, Applications and reviews, ISSN 1094-6977. [Print ed.], May 2010, vol. 40, no. 3, str. 287-297. [COBISS.SI-ID 7683668]

LOTRIČ, Uroš, BULIĆ, Patricio. Applicability of approximate multipliers in hardware neural networks. Neurocomputing, ISSN 0925-2312. [Print ed.], Nov. 2012, vol. 96, str. 57-65, ilustr. [COBISS.SI-ID 9160276]

SLUGA, Davor, CURK, Tomaž, ZUPAN, Blaž, LOTRIČ, Uroš. Acceleration of information-theoretic data analysis with graphics processing units. Przegląd Elektrotechniczny, ISSN 0033-2097, 2012, no. 2, str. 136-139, ilustr. [COBISS.SI-ID 8952148]

CANKAR, Matija, ARTAČ, Matej, ŠTERK, Marjan, LOTRIČ, Uroš, SLIVNIK, Boštjan. Co-allocation with collective requests in grid systems. Journal for universal computer science, ISSN 0948-6968, 2013, vol. 19, no. 3, str. 282-300, ilustr. [COBISS.SI-ID 9797972]

Uroš Lotrič: